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ABSTRACT

The activities of International Education Year enable us to assess the recent spectacular expansion of world education, and the results are scarcely encouraging. There is a growing rift in the industrial nations between educational systems and societies, which is breaking down the school's monopoly as a source of knowledge. If the developing countries continue trying to build educational systems on historic Western models they may be headed for economic disaster and social bankruptcy. Part of the solution lies in more efficient use of educational research and technology; not the hasty adoption of technology to patch up shaky educational systems, but full and integrated use of all the resources of technology for helping each individual acquire and use knowledge. And instead of continuing to let the technology do only what the teacher cannot do, we should ask ourselves what the teacher should do that the machine cannot. The educational model we should move toward is one that offers a community service of self-instruction for safeguarding individual freedom of action. (MG)

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EDUCATIONAL TECHNOLOGY AND DEVELOPMENT OF EDUCATION

by

Henri DIEUZEIDE[1]

"Everybody talks about the weather,
but nobody does anything about it"

Mark Twain

The activities of International Education Year have enabled us to make an assessment of the spectacular expansion of world education which on the whole is scarcely encouraging. It shows lagging quality in contrast with increasing quantity, inadequate output both internal and external, doubts and moral crisis.(2) Attention has also been drawn to the growing rift between the educational systems and a society which is breaking the school's monopoly as the source of knowledge, developing through communication media new relationships between man and the world, and obliging all men to continue their education throughout their professional and civic life. (3) It is admitted today that the developing countries, by seeking to multiply indefinitely existing forms of education based on the historic models of the West, are heading rapidly for economic disaster and social bankruptcy. (4) It has become evident that, since the human and financial resources devoted to education have now practically everywhere reached (and often exceeded) their limit in return for inadequate results, improvement in educational output must depend on a distribution of resources geared to a revision of targets.

How can we go about this? First of all, there is no doubt that the institution of new and more productive educational patterns demands that a certain number of pseudo-theorems which at present block all educational progress, must be strictly and searchingly examined.

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(1) Henri Dieuzeide, who is a holder of the University agrégation, created and directed the French radio and television service for schools (1954-1967) before joining the Unesco Secretariat as Director of the Division of Educational Methods, Materials and Techniques. He is the author of a number of works on education, including a manual on audio-visual aids published in five languages.

(2) See especially International Education Year documents entitled Reflections on Democratization of Secondary and Higher Education and Educating for Development.

(3) See Paul LENGRAND - Introduction à l'Education Permanente, Unesco-A.I.E., 1970, 100 p.

(4) See Ph. COOMBS, The world educational crisis - a systems analysis. Paris, Unesco/IIEP, 1967.

One example is sufficient for the moment: educational research has never been able to establish a relation between the number of pupils in a class and the effectiveness of the instruction they receive. The "ideal formula" - "one teacher for twenty-five pupils" - has no scientific justification. (1) In fact it merely serves as a prop for archaic educational practices, since the sole aim it proposes is to reduce group numbers of pupils in the hope of improving efficiency in the educational process. We may ask, for example, whether it would not be more appropriate to try to equip teachers with materials and methods which would increase their efficiency.

The next step, of course, is to seek to incorporate scientific advance and introduce modern methods and techniques into teaching. The ideal of this untouchable sector, the sanctuary of the "direct relationship", has always been widespread adoption of the tutorial principle. There is a current demand everywhere by pupils and students (often supported by teachers) for more human beings and more humanity in relationship. Wherever attempts have been made (even very timidly) to use machines for communication or analysis in education, they have been naïvely and aggressively condemned as dehumanizing and robot-producing. How many university language laboratories have been abandoned during the last few years, how many television circuits put out of action, and how many computers deliberately paralysed?

These refusals, fostered sometimes by generous utopianism and sometimes by fear of unemployment resulting from technology, deliberately disregard the importance which the new technologies have acquired not merely in physics and mechanics but also in human life (through medicine) and social relations (through communications). Need we remind ourselves, for example, of the growing importance of the knowledge industry, which compiles and commercializes knowledge and renews its assimilation in a thousand different ways (e.g. by encyclopaedias, teaching machines, correspondence courses and language methods)? Information, publicity and political propaganda have devised and brought new and more effective languages of communication into general use. Scientific methods of analysis and organization have developed

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(1) Quite on the contrary, recent research, especially in Canada and the U.S.A., suggests that a reduction in the number of pupils below a certain threshhold yields unsatisfactory results. Similarly, the report of the International Association for Evaluation of Educational Achievement in its International Study of Achievement in Mathematics - A comparison of 12 countries (1967) shows that, in general, "size of class is not related to mathematics achievement...". When a difference is observed, it will be seen that larger classes operate to advantage for younger children whereas smaller classes suit older students better. "To the average teacher, a class of 25 may mean much the same as a class of 35 or 45".....

everywhere; they are transforming industrial organization, political power and military operations and giving an unprecedented impetus to scientific research.

Even in the most developed countries, however, the world of education still knows nothing about operational research, has only a fleeting acquaintance with data processing, and emphatically distrusts cybernetic models. Following suit, public opinion tends to see in the call for new techniques only manipulation and sterilization of the mind.

The time has come to ask whether education must remain the only major human activity in which technology may not increase man's potential, and to denounce the strange and pernicious paradox whereby education is required to change the world without any concession that it must itself be transformed for good and all.

We have today to agree that the progress of technology has raised a series of fundamental issues among educators and those who depend on them (which means, ultimately, society as a whole). To what extent can present advances in communication and organization technology be used to rationalize and derive the best results from the operation of educational systems, and especially to improve all the processes of learning, memorization and transfer of knowledge? What patterns of human and material resources will produce better, quicker and more economical teaching of more individuals? Where positive results have been identified, can they be introduced generally into all educational activities, formal and informal, and in particular be applied to the developing countries? By what strategies could these new technological contributions be introduced into existing educational systems, considering the technical difficulties and human reluctance that they raise?

Innovation and development

We have yet to come to agreement on the still novel concept of educational technology, which produces so many misunderstandings. Recent bibliographies of this subject list hundreds of titles (of treatises, collected articles, publications and reports) issued during the past ten years and dealing in particular with the use of audio-visual equipment (from the fixed film to the language laboratory), new methods of learning (from programmed cards to teaching machines), communication networks (including space communication), analysis systems and computers of every kind.(1) However, among these numerous descriptions of what has been done during the last decade to rationalize the learning act within machine-man systems, few models have actually come into widespread use. The report submitted a few

(1) See, for example, the bibliographies in Teaching and Learning (an introduction to new methods and resources in higher education), Unesco, 1970, 210 p., and in Laboratorio multi-media, studi e ricerche sulle tecnologie dell'educazione (Palombi, Roma, 1970, 588 p.)

weeks ago to President Nixon by the commission of inquiry into instructional technology(1) reveals that even in the United States - the country in which new techniques are more developed than anywhere else in the world - less than 4 per cent of educational expenditure is devoted to educational materials, including textbooks, laboratories and teaching materials of every kind, whereas over 70 per cent of the budget is allocated to teachers' salaries. (It should be noted in passing that this proportion of 4 per cent is, if we are not mistaken, the highest in the world).

The issue today is whether the developing countries, whose educational routines have not yet become sacrosanct, may not ask whether six school years are absolutely necessary to achieve the aims of primary education; whether education must be organized on the basis of academic subjects rather than of tasks and problems; whether categories of individual textbooks must be multiplied indefinitely; and whether it is necessary to build and equip school complexes which are unused for almost six months of the year, and to run radio and television equipment or computers at a quarter or a third of their capacity.

There seems to be a risk that most of those developing countries which seem willing to skip the stages of the slow educational development of the countries which were industrialized in the nineteenth century, will insist on repeating an historical process that will end in a general educational crisis. We should consider whether the introduction of new technologies in education would not enable developing countries to free their schools, while there is still time, from the educational models which belong to the past of the developed countries and of which they imitate, not merely the structure, but also the implicit or explicit objectives.

The continuing fragility of the educational systems of the developing countries is an additional reason for inquiring whether they should consolidate organization and equipment which will be obsolete in a few years' time, or should invest in new structures likely to endure and develop. Such a change is urgent and should take place before the systems become blocked by the hypertrophy which is even now appearing in many developed countries.

I. THE LESSONS OF EXPERIENCE

A survey of the evolution of educational technology in the developed countries should be instructive in this connexion as to what tasks need to be accomplished and as to the magnitude of those tasks, the approach to be selected and the tactics to be employed. Strictly confined at first to marginal and individualized applications, it was subsequently used as a stop-gap treatment for deficiencies in the system before resulting in coherent thinking about the scientific organization of the education process.

(1) To improve Learning, a report to the President and the Congress by the Commission of Instructional Technology, Washington, D.C., 1969, 248 p.

The "craft" approach

The first point to note is that these new techniques have been very slow in finding their way into schools, and only then after having given long proof of their practical value in daily life (duplication techniques, films, television, tape-recorders, and so on). Their increased use has been due, particularly in primary education, to the individual initiative of certain teachers, anxious to establish a new relationship with their pupils, and not to the educational authorities. These techniques have generally been used for fringe activities of extreme diversity. We may quote at random the use of gramophone records and radio in pre-primary schools (singing and games), the use of projectors to illustrate history, geography and general knowledge lessons, use of the tape-recorder for improving oral expression, correcting pronunciation, and narrating stories either individually or in groups, the use of films for the teaching of science, technology, and arts subjects, the use of the radio in teaching music, presenting linguistic models and pronunciation drills, the adoption of television in supervised work, civics, and the introduction of current affairs and contemporary history into traditional education.

Investigation has proved that these activities, at the microcosmic level of the class, have helped in clarifying concepts, stimulating group and individual activities, developing a collective critical awareness, changing attitudes, imposing a new structure or organization on certain subjects, and encouraging originality and creativeness. The use of these techniques has even sometimes made it possible to progress beyond a mere change in the educational climate and, for example, to encourage problem-solving abilities, either collective or individual, or develop self-evaluation processes.

The limits to this approach

All too often, however, it has amounted to nothing more than subjecting the pupils to sporadic bursts of audio-visual information, or the half-hearted attempt to apply the techniques to conventional school activities, and has been based on intuitive judgement rather than measurement of the effects. Use of these aids depends entirely on the teacher and only becomes meaningful when carefully fitted into an educational pattern decided by the teacher himself. In this context, the teacher-"user" tends to be interested only in the "craft" approach to audio-visual methods. Too often his aim is to produce his own documents for his pupils. He prefers using the tape-recorder and the overhead projector in his class rather than drawing on documents prepared on a team basis and produced in quantity such as records, films, and radio and television broadcasts, and thus keeps up the tradition of those generations of teachers who have dictated their lessons, with a sublime disregard for the existence of textbooks.

From the point of view of improving educational output, what hopes does this approach hold out? The strategy of providing each teacher with specialized equipment, maintaining the equipment and giving the teachers special instruction in its use is certainly a useful way of improving "craft" methods,

but a slow and expensive way. The critical mass needed to produce a leap forward in the quality of this output cannot be achieved by injecting new messages in small doses. Economists observe that since these methods are not financed by a redistribution of existing resources, they can only represent additional costs. There is no certainty that the requisite material will be used to the full, since each teacher decides for himself about using it. If costs per pupil often seem low, it is because they are frequently distorted by the fact that the time taken by the qualified teacher in preparing material (projected visual material, sound recordings) is rarely taken into account. A study of the relationship between the time spent by a qualified teacher on this preparation and the results obtained from a very limited number of pupils might well show that the cost is still high. The development of robust and inexpensive equipment such as solar projectors and silk-screen printing equipment for the developing countries, cannot disguise the fact that these are again marginal aids to teaching and do not optimize the rôle of the teacher. However interesting such isolated individual efforts may be, it has to be acknowledged that they have not so far resulted in adequate methods for achieving the rapid expansion of education which development demands. All this goes to explain why these methods have been so slow to catch on.

There is, of course, no question of discouraging these experiments, which play their part in the gradual improvement of traditional educational systems, but it would be dishonest to claim that they are among the fundamental remedies for the present crisis.

An exception: the snowball effect

On the other hand, one of the fields in which there seems to be most justification for continuing and developing these experiments, because of their long-term snowball effects, is without doubt that of teacher training: use of language laboratories for modern language teachers, training in programming techniques for use in the arrangement of subject-matter, use of the closed circuit for improvement of teacher-pupil communication and relationships (critical study by the student teacher concerned of his teaching performance) (1). Similarly, radio and television can be used to provide teachers with "remote control" in-service training. This form of contact helps to avoid the inevitable falling-off in the teaching standards of serving teachers and their failure, sometimes, to keep abreast of developments in their profession when they are geographically isolated or become absorbed into the cultural milieu which it is their duty to change. The UNRWA/Unesco Institute of Education in Beirut, which has managed to combine the use of radio, correspondence courses and programmed instruction for teaching training, constitutes an encouraging example of this use of techniques.

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(1) Cf. Final Report (ED/CONF.14/3) of the meeting on "New Methods and Techniques in Teacher Training", Unesco, 10-23 December 1969.

Palliatives and stop-gaps

Even more significant is the other tendency, particularly prevalent over the last ten years, which has sought to use the resources of educational technology - particularly radio and television networks or new learning processes such as programmed instruction - in an authoritarian manner as an emergency treatment for certain defects in the education system, particularly at secondary level.

In certain cases, educational technology has come to be used as a remedy for inherent deficiencies in the system: in one place to offset the teachers' lack of qualifications by regular broadcast demonstrations or drills or by programmed documents for the pupils; in another, to speed up the introduction of new subjects (new mathematics, nuclear physics, data processing) or new education methods (audio-oral teaching of modern languages); and in yet another (still using radio or television), to take over activities on which the schools have fallen down, using informal methods (intensive courses for second examination attempts, such as Radio Télé-Bac in France and the Ivory Coast).

In other cases the aim has been to extend the field of action of the traditional system to cover new sectors of the public who could not be reached by existing institutions, through the creation of informal education structures based on the use of radio, television, correspondence courses and programmed instruction - extension courses on the lines of the "Junior City College" in Chicago for those not enrolled in schools or replacement education in areas where the educational establishments were non-existent such as the Italian Tele-Scuola, designed to provide the young people in the depressed region of the Mezzogiorno with the rudiments of secondary instruction.

Finally, in other instances the aim has been to eliminate the maladjustments between the school and the social environment by trying, through the use of radio and television in particular, to make up for the cultural handicaps of certain categories of pupils, helping them to learn to express themselves and communicate by familiarizing them with the materials and tools of culture (books, works of art). These broadcasts to prepare children for school or to make up "cultural leeway" have been developed more particularly in the industrialized nations (socialist countries, United Kingdom, United States of America, France).

There is often a tendency nowadays to pass severe judgement on undertakings of this kind, in which political opportunism has frequently taken precedence over educational needs, and their critics are quick to point out that they are superficial and produce only a temporary respite and false economy.

It is true that they have often been hurriedly improvised and (because of the lack of time and sufficient forethought) have not always made the best of the technical resources and specific potential of the media. With the plea of urgency, they have often been put to uses for which they were

not designed: for example, television has often been used simply as a vehicle for a verbal message without any visual content, thus reinforcing old-fashioned practices (authoritarian teaching methods, verbal teaching, stress on learning by heart, encouragement of passive attitudes, glamorization of the television teacher). There has been some justification to speak of "retrograde innovations" which have tended to displace or disguise problems rather than solve them.

It must be said in favour of these operations, however, that their very limitations have given rise to some hard thinking about the impact that the use of communication infrastructures or of industrial methods might have on education: education does not mean only the organizing of micro-activities at the level of small groups - it can use the vast resources of radio, television and programmed material, for instance, to increase its own efficiency. Moreover, the half-hearted combination of technology with a traditional system, by stressing to the point of caricature the worst features of the system, has forcibly emphasized the need to re-examine its aims and its methods. It has now been realized, for example, how absurd it is to use television to create a cultural context based on an élitist culture (introducing children to the theatre, literature and works of art) and imposing it on the children of agricultural or urban workers without first giving thought to the cultural aims of education. The most positive result of these experiments has probably been that they have brought educators, administrators and research workers face-to-face with new concepts and novel technical requirements. They have led - and sometimes compelled - them to take a fresh look at existing systems, their aims and their operation.

Some progressive innovations

Last but not least, these experiments have, over the last two or three years, made possible new and positive lines of approach which go beyond short-term provisional measures. Common features of all of them are that they irrevocably link the use of communication machines with a more scientific organization of school work, they transcend the traditional distinction between school and post-school activities, and they seek to reduce inequality of opportunity.

One of the most obvious examples is the use of inertia-free information networks, such as radio and television. Unlike distribution circuits of the film library type, these networks make possible the industrial-style production of documents by organized teams of education specialists and their instant, widespread distribution. With their aid an average level of educational information and activity can be maintained in schools which do not all enjoy equally favourable circumstances. The programmed and simultaneous introduction over vast territories of identical pioneering models, the distribution of the elements of a coherent collective motivation, and the constant up-dating of instructions for teachers are possible everywhere today by means of radio, and in increasingly extensive regions by means of television (Niger, Hungary, Cuba, Singapore). (1)

(1) See Unesco mission report: Niger, El Salvador, Samoa (February-March 1969) Collection Programme d'éducation télévisuelle - Vol. 2.

Another example is the attempt to achieve a combination of various communication networks into more coherent and comprehensive organizations, more responsive to diversified requirements. Instances include the new institutions for technical and secondary education, or even part-time higher education ("second chance" schools) which have been developed during recent years in western countries and which combine the distribution of programmed documents, the broadcasting of instructions, information models and demonstrations on radio and television, information "feedback" through correspondence courses, the telephone or the duplex system, face-to-face contact provided by travelling instructors, study in small groups and supplementary summer schools ("Tele-Kolleg" in the Federal Republic of Germany, "Telepolytechnic" in Poland). (1)

Alongside these methods which combine extremely varied resources, we can also see the emergence of complex arrays of integrated installations designed to provide intensive accelerated courses on an individual basis: learning laboratories, television circuits, teaching machines, individual response control systems, response analysers, simulation, computers with audio-visual terminals, and so on. This costly apparatus whereby one learns "by appointment" requires, if it is to be an economic proposition, intensive and co-ordinated collective use; it provides a blue-print in certain developed countries for what great educational centres for intensive courses, on the lines of teaching hospitals(2), could be like.

It will be noted finally that with the development of research in cognitive psychology and in behaviour study laboratories, and more especially the different forms of the programming of learning (operant conditioning in America, learning algorithms in the USSR), the users of the new technologies have been led to state education problems in more precise terms as regards aims, organization of the subject to be taught, nature of the activity of the learner, and evaluation and control methods in relation to these aims and activities.(3) This Copernican revolution in teaching which transfers the centre of gravity of educational thinking and research from the teacher's functions and activities (teacher-centred mentality) to the terminal behaviour of the pupil (pupil-centred approach) enlarges the prospects opened up by "educational technology".

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(1) See the Tele-Polytechnic report - Television for higher technical education of the employed - a first report on a pilot project in Poland, No. 55 in the Reports and Papers on Mass Communication series, Unesco, Paris, 1969

(2) See Report EDS/MMT/CAI-TM - Consultation on computer-assisted instruction for developing countries.

(3) See Report ED/ENPRO/17 - Seminar on Programmed Instruction, Varna (Bulgaria), 19-29 August 1968, and
- Unesco/ILO seminar on the application of programmed instruction to technical and science teaching, Turin, 10-24 July 1969

II. THE NEED FOR RATIONALIZATION

The technology of education as distinct from technology in education

International Education Year probably marks the point at which we can start to move away from thinking about technology in education, i.e. thinking chiefly concerned with equipment, the elaboration of ad hoc messages and the incorporation of technology into traditional teacher-centred activities - to thinking about the technology of education, i.e. the systematic application of the resources of scientific knowledge to the process that each individual has to go through in order to acquire and use knowledge. The aim behind such thinking should be to move away from dispersion of effort and waste (or, worse still, the over-hasty adoption of technology as a means of patching-up shaky educational systems) to a full and integrated use of all the resources of the technological age. Hitherto, these areas in education to which technology has been applied have all too often resembled patches of ground strewn with machine parts that no one would attempt to assemble. Has not the time now come to put these parts together?

Instead of attempting merely to recruit and train an ever-increasing number of teachers, whose tasks will become increasingly complex, why not analyse the various educational functions with a view to redistributing the various human and material resources available wherever in the educational system their potential can be most fully realized? This implies the acceptance on our part that, INSTEAD OF CONTINUING TO LET THE MACHINE DO ONLY WHAT THE TEACHER CANNOT DO, WE SHOULD ASK OURSELVES WHAT IT IS THE TEACHER SHOULD DO THAT THE MACHINE CANNOT DO. This further implies the acceptance of far-reaching changes in the organization and hierarchical structures of the educational establishment and in the responsibilities and functions of pupils and teachers alike. There may then be some hope that technology will cease to be a miscellaneous collection of new equipment and methods, designed to lighten some of the teacher's traditional tasks, and will offer a coherent set of liberal methods and original concepts of learning and training which will free teachers and pupils from the haunting fear of failure and fear of each other, which are characteristics of the traditional, elitist institutions.

Such are the means now at our disposal - new display devices (overhead projectors) and, more important still, image and sound recording and reproduction devices (duplicating machines, tape-recorders, video-tape recorders, micro-cards), the storage and collective or individual retrieval, at will, of image and sound (televised films, cassettes, the E.V.R. and Selectavision systems, video-discs, etc.), self-scoring and self-assessment possibilities, the feed-back facilities and flexibility offered by some techniques (ranging from the individual response control system to the computer) or by particular methods of presentation (programming) - that modern technology, with its methods of organization and measurement, its evaluation and experimentation techniques, can, it seems, provide education with the guiding principles upon which to base a definition of the relationship between various new techniques and methods and between them and the institutions,

content and existing methods of education, which they could help transform from within. The transition from technology in education to the technology of education involves a thorough reappraisal of the existing educational system, of its objectives and of the means used to attain them, before any decision is reached to employ these new techniques for specific teaching purposes. The teacher-turned-technologist can then gradually assume the functions of an "educational engineer" whose job it is to increase the output of the entire scholastic machine.(1)

The comprehensive approach

Over the past few years experience has shown that educational innovations, technological or otherwise, cannot simply be introduced in the form of a local transplant on to a particular point of the existing educational anatomy. Such innovations are meaningful and effective only in relation to their effects upon the body as a whole. We have recently had the opportunity of seeing the futility of introducing school curricula involving, e.g. the acquisition of new knowledge or of new methods of teaching (like applied linguistics or new mathematics at a particular level) unless instructors and teachers and the manufacturers of teaching materials are consulted. We have similarly learnt the absurdity of teaching a particular section of the population to read and write and then not supplying them with satisfactory printed material (local press, occupational handbooks, etc.). The school today is an organic unit in which the teacher is only one teaching agent among others, just as the school itself is only one component of a larger overall educational activity. The need for technological change bids us today to turn the eye of the biologist or of the mechanic on the educational system and see it as an organism.

The methods of organization which have developed over the past few years under such names as "operational research" or "systems analysis" appear to be suitable intellectual instruments for an overall critical study of existing systems and for suggesting new educational configurations, based on scientific principles, in which there would be a place for the resources of technology. Why not apply relevance trees or critical path analysis to the bottlenecks in the educational systems? Would it not be possible to apply the principles of feed-back and self-correction to the active functioning of educational institutions? Again, more generally, how can there be any hope of a rational improvement in educational activities without measuring and analysing their functioning?

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(1) See report on the meeting held to discuss the training of educational technologists, National Commission of the Federal Republic of Germany for Unesco, Constance, 18-22 June 1970.

We know that by the term system analysts mean the sum of separate parts acting both independently and on one another to achieve predetermined objectives; the system is therefore defined by reference not only to its constituent parts, but to the organization that allows it to function. In any analysis of a system the aim is therefore to measure exactly the objectives to be attained in terms of performance, to define the levels of application, to allow for the constraints under which it operates and arrive at rational operating models. Can this effort, the aim of which is to define logical structures incorporating all the constituent parts and to marshal the various agents into a unified process in pursuit of maximum efficiency, be applied to the educational process?

In human activities other than education these coherent sets of methods have made it possible to detect the weak points and failings in a given organization which need remedying, to choose from a range of schemes for improvement, to rearrange the constituent parts of a body in various combinations or to add new parts to it in order to secure new results. Systems analysis should make it possible to define for any given organization an optimum structure which maintains equilibrium by means of successive readjustments to the environment. True, the experts are ready to admit that education is too complex an overall process to be analysed otherwise than in terms of probability: education is an open system. However, the thing about systems analysis is that it makes it possible to incorporate uncertainty into action. Since the new technologies are constantly coming up with further sources of information and analysis, increasingly powerful memory units and increasingly sophisticated control mechanisms, it becomes possible to envisage the development - in some cases still rudimentary and in others already more advanced - of self-organising and self-regulating educational systems, both at individual level (self-instruction) and at the level of the educational institution (continuous feed-back of information permitting continuous adjustment). The educational system itself could thus steer a more accurate course than at present by means of the incoming reactions and hence be able to evolve, adapt and grow by mastering change. (1)

An example of analysis: the act of learning

First, however, it must be given the means of establishing correlations between the objectives, the learning processes, the means of instruction and the teacher's functions. The analysis of the various components and various points in the act of learning will then make it possible to use, on each separate occasion, the situation and the means best adapted to the end in view. In the act of learning we can distinguish, for example, an information stage, characterized by research and the collecting together of the data that have to be acquired; an exploitation stage, which involves the marshalling, criticism and processing of the data that have been gathered; an assimilation stage, in which the knowledge is fixed; a transfer stage, in which the knowledge is applied and, lastly, an assessment (or self-assessment) stage.

(1) See report of the international study party on educational technology and the learning process, Geneva, 14-26 May 1970.

Only the new technologies allow each of these stages to be performed with maximum efficiency. At the first, or "information" stage, technology facilitates individual information by means of visual or audio-visual data banks and documentation and information centres (record libraries, film-slide libraries, etc.). This acquisition of information may be collective in form and involve mass communications (e.g. the cinema and television). The second, or "exploitation" stage is generally characterized by group work and involves the use, for example, of individual response control systems. The period of assimilation and fixation may be individual and involves the use of programmed instruction, teaching machines and learning laboratories, but may also involve group work, for example joint utilization of programmed material or group work on computer terminals. The "transfer" period lends itself to the employment of simulation techniques (closed-circuit television and teaching machines). Response analysers and testing machines in general can be brought in during the "assessment" period. Lastly, recording machines and computers make it possible to keep an individual record of the pupil's progress throughout his school career.

At each point in the learning process and for each application of a particular technique there is a corresponding and different function for the teacher. Before carrying out any educational operation he will have to find the teaching strategy required to apply all the various procedures chosen. During the course of the information phase, his rôle is that of the guide who prepares the stimulants and supplies the documentation which he has himself prepared or chosen. During the exploitation phase, his rôle is that of a mediator or of a group leader who motivates the interactions (and who must, for example, gradually train the members of the group in group leadership). He sees that the ideas which have been acquired are properly understood and helps to discover and correct misunderstandings. During the assimilation and fixation stage, his rôle is one of diagnosis - he prescribes the treatment best suited to the capabilities of the learner. During the transfer phase, his rôle becomes that of an adviser-cum-guide. During the last phase of the learning process, his rôle becomes one of checking, ensuring that the system of marking is uniform and seeing to it that continuity is maintained in the assessment process. At all events, the use of technology will have made the teacher more receptive and will have placed him in a more central position where pupils can more easily approach him with their individual problems. In this connexion, we cannot stress too strongly the fact that the use of educational technology - far from implying any qualitative decline in the rôle of the teacher - frees him from certain purely mechanical tasks of exposition and repetition, thus enabling him to devote himself to the noble and irreplaceable functions of stimulation of interest, diagnosis, motivation and advice.

This of course implies a fairly radical overhaul of the existing educational and administrative arrangements, which are based generally on the individual unit or class - reorganization of time-tables (e.g. so as to fit in joint activities at a particular level), the splitting up of groups of classes, full-time use of schools, continuous assessment, the preparation of educational activities in interdisciplinary teams, dividing and distributing of work among teachers according to their aptitude and experience,

adaptation of buildings to give greater flexibility, responsibility of the pupils themselves for discipline, and the production of a considerable amount of teaching materials. Educational technology can help to reintroduce a certain amount of flexibility into the functioning of the school system, which has been in a rut for decades.

Differentiating

However, it should not be thought that there is any single strategy for scientific reorganization of this kind. The point about systems analysis is rather that it helps to define strategies differentiated according to the degree of economic development, resources and type of educational system.

Thus, for example, as far as the distribution of educational information is concerned, it is possible to think of the dissemination of information in the form of audio-visual broadcasts, either through a restricting and relatively inexpensive system (radio, television) or through a (more expensive) user-controlled system involving the use of telephone lines and computer networks. Systems for the distribution of recordings (films, tape cassettes, teaching-machine programmes, etc.) supplied direct either to educational institutions or to individual students at home are another possibility. These systems of distribution, which are more complex and slower than the broadcasting systems, but which are also more selective and better differentiated, can either be centralized, e.g. in the form of film loan libraries and correspondence tuition centres, or decentralized in the form of commercial distribution direct to customers (e.g. institutional tape library or personal record library).

In countries where there are fewer industrial and professional resources, these new systems could be based upon simpler or more cost-effective equipment, taking into account the needs and objectives of the educational system. In a developing country, therefore, if a system of inertia-free instantaneous broadcasting, such as radio or television is chosen, a particular technique must be employed so as to get the best out of it. Where television is available it will be employed both for school and out-of-school educational purposes. If it is used to transmit programmes for group use, it can also be used to show programmed learning exercises, which would be transmitted by other means (teaching machines) in a country that was better equipped. Television is also used to give instructions to the teacher or instructor as to how he should conduct his teaching and how television can be incorporated in it, and to provide in-service training. The system thus becomes multipurpose. In a number of African countries, however, experience has shown that certain difficulties can arise as a result of combining two different types of transmission network: for example, such a tempting technique as "radiovision" (the projection of slides synchronized with a radio transmission) presents both the disadvantages of being bound by the constraints of broadcasting and the hazards of having to rely on the delivery of the slides.

With a systems approach, it is possible to co-ordinate uses and techniques and to organize them rationally on a continuous basis for the individual learner but also for the group, (class or school grade) and the institution, and at the regional and national level. It is therefore possible, proceeding by analyses, to design a complex set of harmonized functions, ranging from the microsystem of the individual learner to the national macrosystem.(1) Although it is generally accepted that the degree of complexity of systems should increase in proportion to the resources available and the difficulties of the learning process (thus the establishment of a complex technological system will generally be more justified in the case of higher education), in practice there is no reason why such a system should not be applied to functional literacy.

Mass instruction and individualized instruction

Are the methods of strict correlation of educational objectives with the various technological and human resources available, within the framework of a coherent system, such as can be seen emerging today in the developed countries applicable as they stand to the developing countries? The aims of the developed countries and those of the developing countries do not necessarily coincide with respect to the use of technology. For the developed countries, technology essentially means economies in human resources; for the developing countries technology has other possible functions: true, it means the possibility of better distribution of the available human potential, but above all it is part of the race against time. Educationalists in the developing countries will be more inclined to see educational technology as a means of rapid dissemination of urgently-needed education on a massive scale to large groups, whereas the developed countries will see it as a means of increasing the effectiveness of education by making learning a more individual process. This is why there is often a tendancy to make a sharp distinction between mass dissemination techniques (the cinema, radio and television), by means of which it may be possible to solve the tremendous problems of India or Brazil, and individual teaching techniques (programming, teaching machines, learning laboratories, individual response control systems, computer teaching) intended for the "tailor-made", "by appointment" type of education.

This theoretical distinction does not stand up to serious examination, firstly because the mass media by their very nature make it possible to offer a varied range of means of instruction, and consequently, to introduce a certain individualization of instruction. Further, the use of individualized techniques such as programmed instruction combined with group techniques, the audio-visual

(1) "The only way out of this helpless situation is by helping gradually to develop systems of relationship and negotiation and more complex, more open, more comprehensive and more effective sets of rules and customs and regulatory models ... by learning to concentrate the resources of the community on the key points of the systems that have to be helped out of the deplorable vicious circle that they are in, instead of dealing with the adverse effects of the malfunctions and thus contributing to their perpetuation." Michel Crozier, La Société bloquée, (1970) p.230

for instance, has already made possible, in Great Britain and France for example, a fruitful alternation of the global and analytical learning processes. Conversely, we have seen a development in the group use of a single machine (group work with the same programmed material in Central Africa, and on a single computer terminal in Spain) for programmed instruction and computers, for example.

It is at the stage of utilization that the difficulties occur, since this approach requires the industrial manufacture of the basic teaching equipment of a standard type but of high quality and capable of being used on a sufficiently wide scale to be economical. It is well known that it requires about one hundred hours of collective work by specialists to prepare one hour of programmed teaching material and anything up to two hundred hours of work by a team to produce one hour of computer teaching material. The figures are even higher in the case of film-making or the preparation of "pre-packaged instruction". Educational technology implies assembly-line methods for the production of teaching material and a division of labour in its use. It involves in particular the development facilities into which these prefabricated elements can be smoothly adapted and integrated. It will inevitably lead the teacher to reconsider his place and functions within the future school system, no doubt the part played by the school system itself within a developing society based on educational expansion.

The school of tomorrow - factory or self-service establishment?

By making it possible to redistribute human and material resources and by lending support to the attempt to find ways and means of increasing the internal output of the educational institution, the development of educational technology opens up the prospect in the years ahead of developing new types of educational institution radically different in form from the traditional, elitist and selective establishment.

The establishment in which educational technology (audio-visual communication, learning laboratories, data banks) has been incorporated would, according to one model, tend to ressemble an enterprise in which educational technology would be used to reduce wastage to a minimum and to optimize the act of learning by establishing precise mechanisms to produce effective individuals by dint of intellectual constraints, fear and the spectre of failure having first been banished from their training.

In contrast to this deterministic model, based on efficiency, there would be another model, no doubt using similar means but arranged in different configurations. It would offer a community service of individualized self-instruction for safeguarding individual freedom of action - a complete self-service system adaptable to individual needs, to which the pupils would feel an allegiance based on individual involvement.

The first of these formulae would prove particularly useful in immediate vocational training. However, since the society of tomorrow is to be founded on life-long education and since the spirit of his initial training determines the practical interest subsequently shown by a citizen in his own training, the self-teaching centre will, more so than the learning enterprise, be bound up with

life-long education. Teaching will no longer be a matter of forcing information upon pupils (as in the traditional, authoritarian system) or exposing them to knowledge (as in liberal education), but one of instructing the young by the practice of self-teaching - a method calculated to ensure social mobility - how to shape their education by mastering a system and progressing beyond it. Thus; educational technology will not be confined to increasing the internal efficiency of the school centre, it will also increase its involvement with social reality.

III. IN FAVOUR OF A STRATEGY OF TECHNOLOGICAL INNOVATION

We shall next have to ask ourselves how the gradual transition from theoretical models similar to those that have just been described to the stage of effective application is to be made. Conversions have hitherto been from one stable system to another. Here, the leap has to be made, under conditions of permanent instability, from autocratic, fixed, closed and ponderous systems to planned, open, flexible and self-adjusting systems that will admit of the possibility of forecasting and integration.

Three choices

In theory there are three possible innovation strategies. The first is to change everything at the same time, but so far there has been no instance of this having been done anywhere. The second one involves modifying the existing state of affairs by introducing innovation at the lowest level in the system and carrying on from there, the new system pushing the old one in front of it; such is the case with the gradual introduction of television, year by year, involving, in the case of the Ivory Coast, the transformation of primary education and, in the case of El Salvador, of secondary education. The third strategy involves setting up and developing a new system parallel to the old one and capable of replacing it one day; such is the case, for example, of educational television for elementary schools in Niger, or, at another level, of the Open University in the United Kingdom. In the long-term this is no doubt the most effective strategy, although this is not to say that we should not optimize right away the use of technology in education such as it is and undertake localized projects, without waiting until all the conditions are right. It is not inconsistent with an attempt to rationalize the use of educational technology on the basis of models that combine all the data into an integral system. Planning by segment and long-term planning are only two aspects - strategical and tactical - of the same productive effort.

International Education Year should help to define the new intellectual approaches, the original practical measures and renewed international contributions called for by these transition strategies.

An optimistic attitude

If we want to apply systems analysis, we should adopt a coherent overall view of the educational situation. We must take action against the fragmentation of schemes and set priorities, ranging from the project to the full-scale education programme. Those microsystems which can be developed first will probably be in areas less overburdened by antiquated structures and therefore presenting less risk of an abrupt reject - the out-of-school and informal sectors, "remote-controlled" education, part-time education, or sectors under review because of strong external pressures, such as higher education or technical education. Even at the microsystem level care will have to be taken to define an operational critical mass that is sufficient to bring about a chain reaction leading to renewal. Such a changeover should be planned in terms of efforts that it is possible to sustain intellectually; a certain degree of flexibility should be observed in calculating the length of the preparatory period that should precede the changeover, so as to avoid the possibility of discouragement. Similarly, within any given programme a number of alternatives will be kept open, so that a competitive spirit may be maintained and a process of natural selection may operate. Lastly, care will be taken to create a strongly positive climate around the changeover and one that will enable the opportunities for developing the community and improving the lot of individuals to be used to the full. There is nothing more depressing than the gloom surrounding certain innovation schemes in which the difficulties and problems are given undue prominence. Innovative forces should be detected, marshalled and organized. Properly conducted, technical innovation should be a focal point for energies, around which could be grouped efforts at reorganization which could not be undertaken otherwise. There have already been frequent instances of the catalytic effect of school television or programmed instruction in hastening the reform of school curricula and teacher training.

Decompartmentalizing in order to co-ordinate

In practice the aim will be to take steps calculated to modify the attitudes of the majority. Experience shows that the first thing to be done is to improve the internal means of communication in educational institutions and to encourage among those concerned a spirit of continuous self-appraisal. Interdisciplinary work at every level should be used as a means of reducing or eliminating compartmentalization. One of the first stages in this development is to treat as an entity certain problems that are traditionally viewed in isolation or kept artificially apart and, accordingly, to create centres of decision. At the same time an attempt will be made to work out ways in which all those concerned can be associated with the process of innovation; tensions will be resolved by means of participation governor-mechanisms. It is not just a question of group therapy: resistance to innovation is an expression of a social reality and it should not be studied in order to circumvent or destroy it, but to use it as a solid basis for a collective innovatory endeavour.

At the same time an effort will be made to create the material infrastructure for innovation. One of the first tasks, especially in countries with limited resources, will be to see if there are any technological resources that could be more fully utilized: broadcasting agencies, printing facilities, data-processing centres, and so on. It will be essential to co-ordinate the use of such resources in the framework of an overall plan. An attempt will also be made to improve co-operation between the various occupational groups concerned with the development of education. In order to achieve progress in this direction it is essential that the manufacturers of teaching equipment and programme producers rally around explicit educational objectives - in some countries electronics engineers and visual aid manufacturers, textbook publishers and the authors of programmed instruction methods are already trying to combine their efforts (e.g. in the United States of America and the Federal Republic of Germany). Elsewhere national agencies for the production and distribution of new teaching materials have been set up (Sweden, Netherlands); also, in some countries, e.g. Japan or the United Kingdom, various authorities or ministeries have got together to co-ordinate their use of the existing communication networks (radio, telephone, transmitted and piped television) for educational purposes.

The institution

Particular care should be taken to develop centres for the promotion of innovation, whose task it will be to produce - or get those concerned to produce - new school curricula, new systems of evaluation and control and new teaching materials. An effort should also be made to encourage the development, outside the traditional framework, of "centres of excellence" and truly experimental establishments based on new organizational principles, to bring them together, to link them and, if possible, to co-ordinate them in a flexible manner calculated to ensure mutual benefit and to increase their capacity for innovation and their impact.

Consequently it is applied research conducted by interdisciplinary teams that should be encouraged. Its results will not be in the form of reports but of products, which may be new teaching materials (films, teaching equipment, programmed materials), but also methodological systems or new institutional forms. Research done as a pretext, research of the academic kind with a bias towards theoretical generalization should be avoided - industry and medicine are standing proof that effective methods can be generally introduced without being given a formal basis in theory.

Lastly, the aim will be to inform and to train - to inform the public in so far as it is the customer of the educational system, and especially pupil's families, whose attitude is often wary, and to train the teachers and change the old patterns that they have been used to following in order to prepare them for the new rôles that educational technology has marked out for them, especially their rôle as in-school and out-of-school leaders. Such training should be

given to serving teachers as well as to student teachers, and this will be possible through the transformation of the professional training institutes into life-long training institutes having at their command all the resources of modern educational technology. Further, special attention will have to be given to the training of a corps of "educational technologists", i.e. of specialists of all levels who, according to some experts, may in twenty years' time account for anything up to 10% of the total of all those employed in education. These people will be specialists in the revision of objectives and curricula, testing and measurement specialists, administrators of new systems, communications specialists, production and maintenance technicians, etc.

Preparing the ground

International assistance programmes should also be rethought with a view to the systematic development of innovation, taking due care not to spread resources too thinly or to disperse efforts too widely. New avenues are at present being opened up by the tentative start on integrated educational planning that has been made in Algeria and in Indonesia. Aid should stimulate and not paralyse communication between the motive elements of innovation within the country concerned (research centres and production centres). Consideration should be given to the idea of an international network for liaison between these elements, involving the use of the most up-to-date means of communication and exchange (computers and space communication in particular) and making it possible to achieve a better division of assistance work. Some national centres could be formed into support centres to develop educational technology at the regional level. The one at present being built in Mexico for Latin America (ILCE), or the one planned for Japan to cover the Asian States, should be both information centres using the most up-to-date communication technology and centres for training and research geared to technological innovation. These regional networks and centres should be backed by task forces made up of specialists who, at the request of Governments, may be called into help fit new educational strategies based on systems analysis and technology to the country's special needs. Lastly, it is to be hoped that international assistance agencies may set an example of the new approach in their own structures by setting up interdisciplinary units entrusted with specific missions in place of the traditional system of compartmentalization by disciplines and techniques.

Of course, such new arrangements only have any meaning if they are supported by appropriate political decisions, as was the case recently when Sweden, Singapore and Cuba took the decision to bring in educational technology as a means of developing education.

In this connexion it should be noted that International Education Year could mark an important turning point. New efforts to think the problem through, combined with new efforts at the organizational level are being made with Unesco's assistance, with a view to reducing the fatal disproportion between the ever-increasing rate at which technology is advancing and the standstill in educational thinking that we find at the present day.

The Ivory Coast, for instance, has decided to link curriculum reform, the overhaul of teacher training and the systematic use of television for schools to ensure that its primary education system is better adapted economically and culturally, to the environment. India is considering the production of visually-based teaching programmes suitable for use with the various forms of educational technology as and when they appear, including space communication. Indonesia is employing the systems approach for the first time on a national scale as a means of analysing the state of its schools and determining what part schools radio should play in it. Spain is studying the setting up of a network of computers for the rapid training of a new type of secondary school teacher of the kind that the country will need most urgently in the coming decade. Lastly, the States of the Andean region have initiated studies with a view to determining to what extent space communication can be used to speed up educational integration in the region.

In all these cases, an attempt has been made to make an overall analysis of the general state of affairs in the field of education. Projections of the possible futures of education are carried out before any decisions are made on fitting educational technology into the development of education, so that it may play its true rôle, which is to help transform the very nature of the educational system into which it is to be incorporated.

CONCLUSION: IS IT SUITABLE FOR GENERAL INTRODUCTION?

There remains the problem of the price that must be paid for this innovation. It has to be admitted today that innovation is a costly affair and that it is no longer a question of choosing between whether to innovate or not to innovate, but of knowing how to innovate at greater or lesser cost and over a longer or shorter period of time. It is then permissible to look beyond the cost-benefit ratio and to compare costs and performance.

A reasonable proposition

It has been established that in most Member States educational expenditure is tending to mount regularly, year in, year out, by anything from 5% to 8% depending on the country; most of this increase is accounted for by rising teachers' salaries. The question today is whether priority should not be given to investment that seems likely to have a positive long-term effect on the efficiency of education. MIGHT NOT INTERNATIONAL EDUCATION YEAR BE AN OPPORTUNITY FOR EDUCATIONALISTS TO ASK - AND FOR GOVERNMENTS TO DECIDE - THAT SOME OF THE INCREASE IN NATIONAL EDUCATIONAL EXPENDITURE ALREADY SCHEDULED FOR THE COMING DECADE (SAY HALF) BE DEVOTED EXCLUSIVELY TO REFINING THE WAYS AND MEANS BEST CALCULATED TO ENSURE A RAPID INCREASE IN THE EFFICIENCY OF THE EDUCATIONAL SYSTEM AND MORE ESPECIALLY, THE RATIONAL DEVELOPMENT OF EDUCATIONAL TECHNOLOGY?(1)

(1) The Director-General of Unesco, in his Long-Term Outline Plan for 1971-1976, submitted to the sixteenth session of the General Conference, has already proposed (taking an estimated average increase of 7% in the Organization's budget) a rate of increase of 15% to 20% for curricula and methods.

Since the purpose of educational technology is not to provide each individual teacher with his own audio-visual outfit, but to reform the functioning of the educational system, and since its introduction provides the opportunity for analysing - and perhaps for reorganizing - the existing institutions, it is within the available or foreseeable budgetary provisions that educational technology must be introduced, by adjustment of educational practices to resources and vice-versa. In a number of European countries the establishment of experimental institutions has been rendered possible by an all-out effort to reorganize teaching spaces and to rethink fittings and equipment. Within a given context this involves a comparison of the effectiveness of the old system with that of the new educational pattern. It is a question of finding out which teaches the greater number of subjects best in terms of quantity and quality, in more places and in the same or less time.

The programme that has been undertaken in the Ivory Coast for the incorporation of television into primary education is based on a planned reduction by half over a period of ten years in the present drop-out rate and on an increase in operating costs in the region of 8 per cent, which would be covered by the estimated increase in national revenue. The integration of educational technology is no longer calculated here in terms of additional expenditure, but in terms of overall expenditure.

We would add that recent studies by economists would seem to indicate that there is an optimum level for the distribution of resources within an education system beyond which there is no longer any improvement in the results. It is this state of equilibrium which must be sought and attained. Educational technology first of all provides the opportunity for subjecting education to internal scrutiny and then for measuring it against other human activities.

Technology and machines

Such a scrutiny can hardly be put off much longer. This is not to say that laboratory research into the processes of learning have made any particularly rapid progress in this respect - "sleep teaching" and subliminal stimulation, for instance, remain at the stage of working hypotheses. On the other hand, the economic and technical pressures created by the new equipment are mounting: their miniaturization, their reliability, falling costs and their rapid and widespread introduction are augmenting their educational potential - direct communication links via space, video discs and quarter-inch video-tape recorders, desk-top computers, etc.

Countries with limited resources should not imagine that they are not affected by this: technology is not just a question of hardware but one of man thinking about the nature, function and rational use of tools. Educational technology is not about how the machine is to be incorporated but how technological principles are to be transferred. Technological invention is not tied to a particular level of GNP.

One of the major tasks to which International Education Year should invite the developing countries to address themselves is certainly that of the acculturation of educational technology. A particular requirement of the developing countries (e.g. the development of fine motor skills or the learning of the perceptions and associations peculiar to a literate civilization) should be no bar to the adaptation of already proven programming methods. The need to produce educational materials locally should not rule out but on the contrary justify the simultaneous appraisal and application of programmes and techniques that have already proved their reliability in the developed countries. The combined criteria of educational output and economic viability should soon make it possible to define the proper balance that must be struck between local contributions and outside contributions.

This does not necessarily mean that the key to educational technology is to mechanize schools through and through and transform educators into push-button operators. It is not the teaching machine that is important, but the programming principles which can be deduced therefrom, and one could even go so far as to imagine educational technology based on non-existent machines reconstituted from the functions that they are required to carry out. There are no physical, mechanical parts in the "little machines" which the mathematician Dienes uses to introduce young children to modern mathematics - they are merely new "modes of thought" expressed as a game. Similarly, the most effective way of introducing people to the new concepts of information science is to turn a blind eye to the question of how computers function. And it is no coincidence that there is a trend in the most up-to-date forms of educational technology towards simulation, i.e. towards devices which seek to deny their own existence. If there could also be in education an "intermediary" technology not involving any complex machinery, it is no doubt for the developing countries to discover it and to develop it in the years ahead.

Is it really necessary?

Educational technology does not provide a miracle cure for the world crisis in education, but it does invite us to make a relatively simple effort at rationalization that goes further than the categories and pipe dreams that we have today.

True, education, which is concerned with values, cannot be entirely rationalized, if only because the demand for education is in itself an irrational phenomenon. Education has a great many other functions besides transmitting acquired knowledge and turning out lucid and effective future citizens. Educational institutions, according to their various levels, function as places for child minding and protection, as centres in which national unity may be forged and in which a civic education or a pre-military training may be given, but also as places where the individual learns to find his place in society and as a ritual instrument by means of which the individual is initiated into adult life. The crisis of

education is not going to be completely solved by the introduction of technological principles and machinery. But by inducing each educational system to re-examine the functions of production and control, to create for itself a new and more flexible structure and to generate within itself new rôles and new human relations by making it adaptable and flexible are we not enabling it to fulfil its other functions better and, if need be, to reconsider its ultimate purpose with the requisite lucidity?